THE STATE OF OKLAHOMA

2004
WATER QUALITY ASSESSMENT
INTEGRATED REPORT

PREPARED PURSUANT TO SECTION 303(d) AND SECTION 305(b)
OF THE CLEAN WATER ACT

Prepared by
OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Groundwater Quality

Overview

Groundwater is an important natural resource in Oklahoma. There are twenty-one major groundwater basins in the state and approximately 150 minor basins. These major basins are used as primary source of community drinking water and are estimated to hold over 320 million acre-feet of fresh water. See Figure 7 for a detailed map of the "Major Bedrock Aquifers in Oklahoma" and Figure 8 for the "Alluvium and Terrace Deposits in Oklahoma."

The Oklahoma CAFO Act puts measures into place that prohibit a hydrologic connection between generated wastewater and waters of the state. The Act further states that samples of water from Licensed Managed Feeding Operations (LMFO) monitoring wells located around swine lagoons shall be collected by the ODAFF and tested at least annually. The main goal of the monitoring program is to determine if the groundwater at or near the LMFOs are subject to degradation as a result of the operation of the facility. From the data collected from 1999 to 2001, monitoring well sampling has shown in certain wells the nitrate as nitrogen analytical results exceeding the USEPA Safe Drinking Water Act maximum contaminate level (MCL) of 10 mg/L. The ODAFF contracted with the U.S. Geological Survey (USGS) to resample and study the possible sources of nitrate in groundwater from wells that exceeded the MCL from 79 monitoring wells at 35 LMFOs. In addition to chemical and microbiological analysis, the USGS used nitrogen isotope ratios in nitrate and ammonia and bacteria ribo-typing to determine the possible source of nitrates. These procedures indicated that, in a total of five monitoring wells at four LMFO facilities, the possible source of contamination was from swine waste.

There are extensive groundwater brine plumes in some old oilfield areas due to the former practice of dumping produced brines into "evaporation pits", which has been banned for years. Brine has migrated from the old pits into underlying soils and groundwater. Drinking water wells in the areas have been rendered un-usable, and many streams are now being impacted by saline groundwater plumes that emanate from the old "evaporation pit" areas. Counties where this has been identified as a known or likely problem include Pottawatomie, Seminole, Kay, Oklahoma, Carter, and Stephens. To determine the extent of this problem, the Corporation Commission and its partners (OWRB, and OCC) have been sampling many streams and several hundred wells per year in old oilfield areas where there was brine production . Most of the 80 plus streams listed in Category 5 for a saline/TDS/chloride cause are a result of this oilfield area sampling program. The complete Corporation Commission sampling dataset can be obtained electronically at

ftp://ftp.deq.state.ok.us/wqd/corp_comm_ground_water_sampling_data.xls

Since 1996 the Corporation Commission has collected approximately 225 ground water samples per year near known and suspected oil and gas spill sites and/or in response to complaints from citizens in oil and gas field areas. These are taken in domestic water wells; in pollution monitoring wells, borings and dug trenches; and from springs and seeps where groundwater emerges at the surface. Samples are analyzed for salinity, petroleum, metals, or other parameters as appropriate, in order to determine what actions are needed in each case.

Corp Comm is also attempting to utilize this data in conjunction with surface water data to determine potential sources of watershed impairments and areas in which corrective action should be taken. For example, many of the salinity impacted streams found to date have no surface source. Ground water samples taken near some of these streams show that there is a subsurface brine plume, probably the source for the stream's excess salinity. If the source for each brine plume could be determined and remediated, then the plume(s) may no longer carry pollutants to the streams and cause stream impairments.

Corp Comm is using its current ground water sampling data for this purpose in a few areas, but does not yet have the funding to undertake extensive sampling near impaired streams to determine the potential groundwater sources for all impaired streams.

In 1984, the OWRB established a monitoring network to determine the ambient quality of major aquifers for the development of numeric groundwater quality standards. Between 1984 and 1992, the OWRB collected annual samples from a network of more than 200 domestic, irrigation, stock, and municipal water wells. Samples were analyzed for major ions and metals. Unfortunately, this program was discontinued after nine years of data collection due to lack of funding. However, the OWRB continues to conduct sampling of major aquifers as part of their basin studies and Beneficial Use Monitoring Program (BUMP). For example, in 2001 the OWRB sampled 61 wells in the Cimarron Alluvium and Terrace aquifer for nutrients and major ions. In 2002, 64 wells in the North Fork of the Red River Alluvium and Terrace aquifer were sampled for major ions.

The OWRB has also conducted statewide monitoring of groundwater *quantity* since 1937 through the mass measurement program, in which water levels in more than 700 wells are measured annually to assess long-term trends in groundwater levels and aquifer storage.

The DEQ has 2 monitoring programs that address groundwater: the Public Water Supply Monitoring Program and a 106 Ambient Groundwater Monitoring program. Public water supplies must collect samples at various intervals and locations to determine if the water they serve the public complies with primary drinking water standards as set forth in the Safe Drinking Water Act. Most of these samples are collected at points of entry into the distribution system. The water entering the system at the points of entry can represent one or several groundwater sources. This data is compiled and used to determine areas of contamination and to set expected concentration ranges of various chemical contaminants. Historic data has been compiled going back to the 1920's and future data can be compared to historic ranges to determine changes over time. Intentions are to identify potential concerns before they become major problems.

The DEQ's 106 Groundwater Monitoring Program will use public water supply operators to collect samples from 400 randomly selected PWS wells annually. Samples will be analyzed for secondary drinking water parameters and major ions. Data will be used to evaluate and classify groundwater quality and determine aquifer homogeneity. The monitoring data, once analyzed, verified, and compiled will be made available to State agencies, federal agencies, and the citizens of Oklahoma for their use. Trends established by this ambient monitoring program can be used to identify sources of polluted runoff that potentially could adversely impact vulnerable groundwater resources.

The DEQ has several remediation programs that identify, monitor, and when needed, remediate local sources of ground water pollution from releases at regulated facilities, historical releases, and spills. Most of these sources are very localized and are not included as areas with problems or concerns.

Major Aquifers with Anthropogenic Water Quality Problems or Concerns

Major aquifers are defined as aquifers which can effectively yield 150 gallons per minute or greater. The following information is based on samples submitted to The DEQ of domestic wells and through the PWS program. This information is based upon the most recent information provided to this division as of December of 2002. For location of the major aquifers, please refer to the maps "Alluvium and Terrace Deposits in Oklahoma" and "Major Bedrock Aquifers in Oklahoma".

Alluvium and Terrace Deposits of the Salt Fork of the Arkansas River

The DEQ has identified several wells and well fields in this aquifer with elevated nitrate levels.

Alluvium and Terrace Deposits of the Arkansas River

The DEQ has identified several wells and well fields in this aquifer with elevated nitrate levels.

Alluvium and Terrace Deposits of the Enid Isolated Terrace Deposits

The DEQ has identified a well in this aquifer with elevated nitrate levels.

FIGURE 7. MAJOR BEDROCK AQUIFERS IN OKLAHOMA

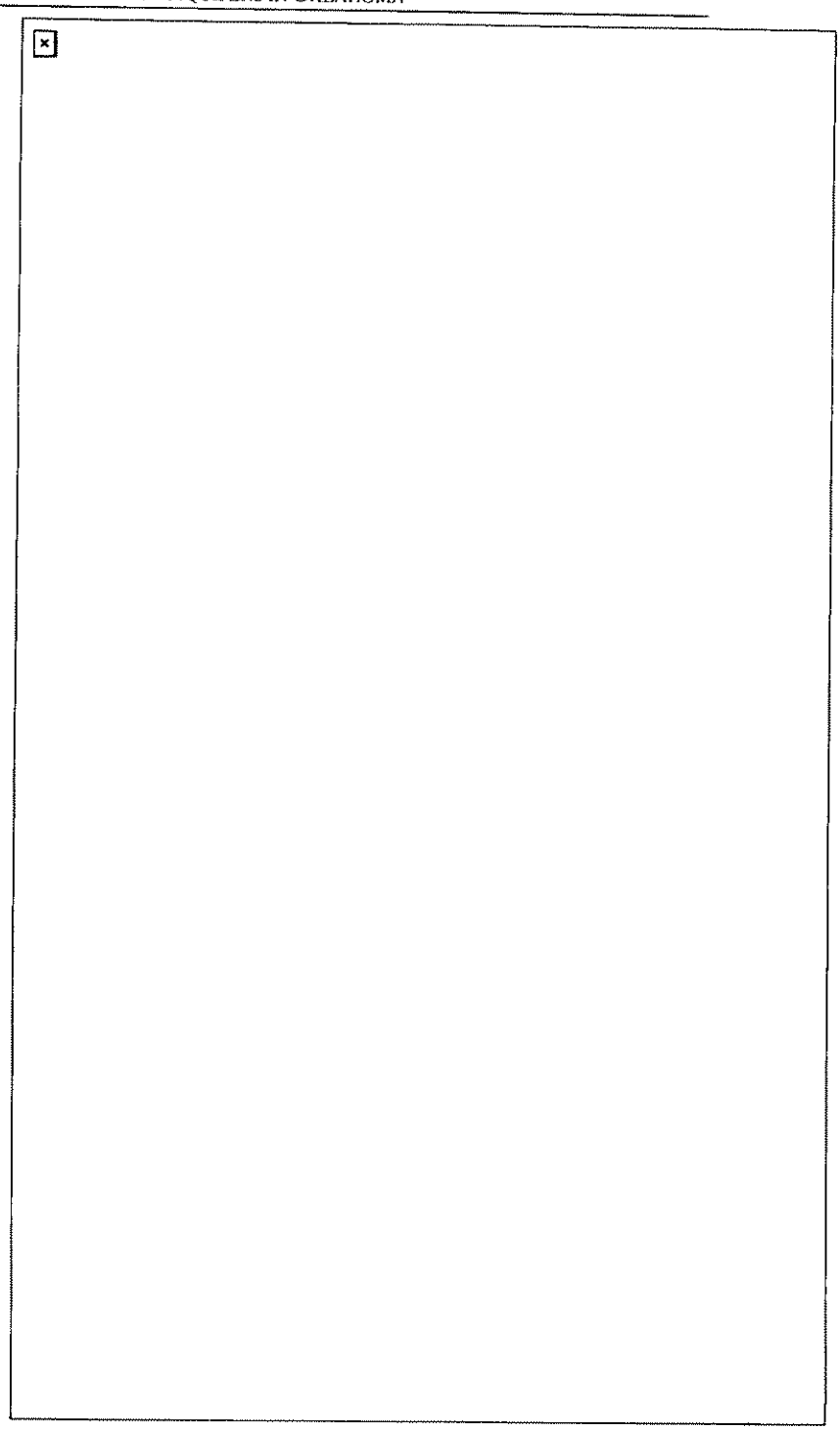
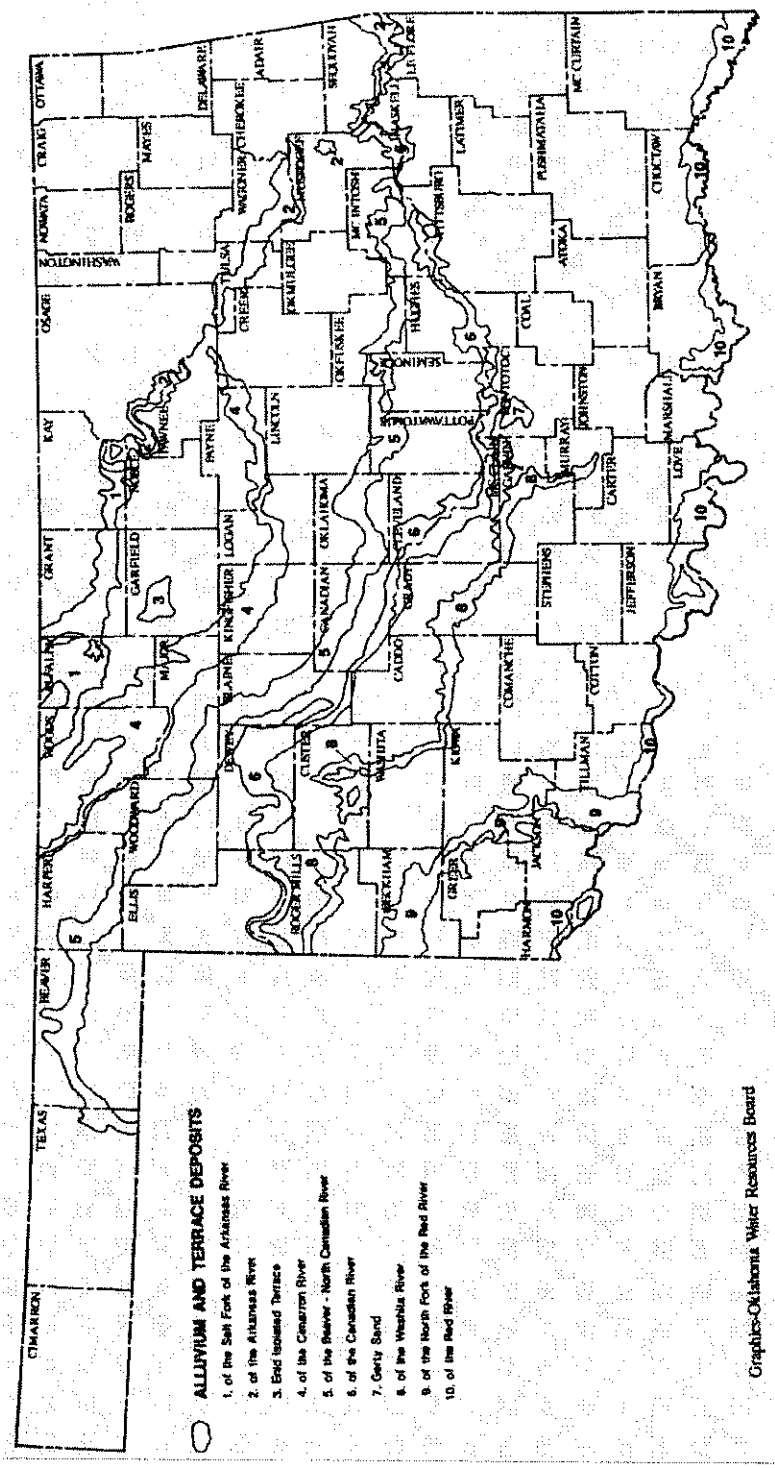


FIGURE 8. ALLUVIUM AND TERRACE DEPOSITS IN OKLAHOMA



Alluvium and Terrace Deposits of the Cimarron River

The DEQ has identified several wells and well fields in this aquifer with elevated nitrate levels.

Alluvium and Terrace Deposits of the Beaver-North Canadian River

The DEQ has identified several wells and well fields in this aquifer with elevated nitrate levels.

Alluvium and Terrace Deposits of the Canadian River

The DEQ has identified several wells and well fields in this aquifer with elevated nitrate levels.

Alluvium and Terrace Deposits of the Washita River

The DEQ has identified a well field in this aquifer with elevated nitrate levels.

Alluvium and Terrace Deposits of the North Fork of the Red River

The DEQ has identified several wells and well fields in this aquifer with elevated nitrate levels.

Alluvium and Terrace Deposits of the Red River

The DEQ has identified several wells and well fields in this aquifer with elevated nitrate levels.

Ogallala Formation

The DEQ has identified a well field in this aquifer with elevated nitrate levels. Some of the wells showed elevated levels of selenium, probably of natural origin.

Antlers Sandstone

The DEQ has identified several monitoring wells in this aquifer with elevated nitrate levels. Some of the wells showed consistently low pH values.

Rush Springs Sandstone

The DEQ has identified several wells, monitoring wells and well fields in this aquifer with elevated nitrate levels and a well field with hydrocarbon and chloride contaminations. The contamination is the result of historic oil and gas activities (extraction, refinement, and salt-water disposal).

Garber Sandstone and Wellington Formation

The DEQ has identified several wells in this aquifer with gross alpha activity above the maximum allowable limit of 15 pCi/L. The Department has also identified several wells and well fields with selenium contamination. Localized wells and monitoring wells have been identified with industrial solvent contamination. Several wells have been detected with elevated levels of nitrates and chlorides. Arsenic is naturally occurring within this aquifer and several excursions above the new MCL of 10 ug/l have been noted via DEQ source monitoring actions.

Roubidoux Formation

The DEQ has identified several newly installed wells in this aquifer that show local elevated iron, sufate, and total dissolved solid levels in Ottawa County attributed to mine water contamination from historical mining from the Tar Creek Superfund site. The intervening Boone Formation is heavily impacted by the mining and is the source for localized problems within the Roubidoux. DEQ and EPA continue to monitor water quality in this area under the After Action Monitoring Program.

Vamoosa Formation

The DEQ has identified several wells in this aquifer with elevated fluoride levels. The DEQ, the OWRB, and the United States Geological Survey have identified several wells and well fields with chloride contamination.

The Arbuckle Formation

The DEQ has identified several monitoring wells in this aquifer with elevated fluoride levels and a tendency towards excessive hardness. There are no known groundwater based community public drinking water systems experiencing water quality problems. The source appears to be natural and has therefore limited the usefulness of this formation as a drinking water source.

Non-major Aquifers with Anthropogenic Water Quality Problems or Concerns

Non-major aquifers are defined as aquifers which effectively yield less than 150 gallons per minute. The following information is based primarily on individual wells or well fields that were affected by problems. These wells may or may not constitute a public water supply. In most cases, the problem wells are not in use, or have had their water blended with other sources to reduce the contaminant(s) to acceptable level(s). For location of the major aquifers, please refer to the maps "Alluvium and Terrace Deposits in Oklahoma" and "Major Bedrock Aquifers in Oklahoma".

The Boone Formation/Boone Chert/Keokuk and Reeds Springs Formation

The DEQ and the OWRB have identified several monitoring wells in this aquifer at the Tar Creek Superfund site in Ottawa County with low pH levels and heavy metal contamination. The source of contamination is from historic mining operations. This formation overlays the Roubidoux Formation. The Roubidoux Formation is threatened and locally impacted near several monitoring wells due to the severity of the contamination in the overlaying formations.

The Oscar "A" Formation

The DEQ has identified several wells in this aquifer with elevated nitrate levels and gross alpha activity above the maximum allowable limit of 15 pCi/L. These concerns are similar to those expressed for the Garber/Wellington Formation.

McAlester and Hartshorne Formation-Savanna Formation/McAlester Formation/Hartshorne Sandstone Formation

The DEQ has identified several monitoring wells in this aquifer with low pH levels, heavy metal contamination, chlorides, and some controlled industrial wastes. The source of contamination is from historic mining operations and off-site disposal pits for oil field and industrial waste.

Walnut Creek Alluvium Deposits

The DEQ has identified two well fields in this aquifer with elevated nitrate levels.

Tillman Terrace Deposits

The DEQ has identified two well fields in this aquifer with elevated nitrate levels and elevated levels of selenium.

Little Sandy Creek Alluvium Deposits

The DEQ has identified a well field in this aquifer with elevated nitrate levels.

West Cache Creek Terrace

The DEQ has identified a well field in this aquifer with elevated nitrate levels.

Major Sources of Contamination

The major sources of contamination within the state are listed in Table 18. The basis used for establishing the priority ranking system was based upon information collected from the various monitoring programs (e.g. the monitoring network, the ambient monitoring program and the wellhead protection program and the Tar Creek After-Action Monitoring Program).

TABLE 18. MAJOR SOURCES OF CONTAMINATION

Contaminant Sources	Highest Priority Sources	Factors Considered in Selecting a Contaminant Source	Contaminants
Agricultural Activities			
Agricultural Chemical Facilities			
Animal Feedlots	√	A - C - D - E	E - J
Drainage Wells			
Fertilizer Applications	√	C - E	E
Irrigation Practices	√	C - E	E
Pesticide Applications			
Storage and Treatment Activities			
Land Application	√	C - D - E	D - E - H - J - L
Material Stockpiles			
Storage Tanks (Above Ground)			
Storage Tanks (Underground)	√	A - C - E	D
Surface Impoundments	√	A - C - D - E	D - E - G - H - J - L
Waste Piles	√	C - D	H
Waste Tailings	√	C - D	H
Disposal Activities			
Deep Injection Wells	√	C - D - E	C - D - G - H
Landfills			
Septic Systems	√	A - C - D - E	E - J - L
Shallow Injection Wells			
Other			
Hazardous Waste Generators			
Hazardous Waste Sites			
Industrial Facilities			
Material Transfer Operations			
Mining and Mine Drainage	√	A – C – D - E	H
Pipelines and Sewer Lines			
Salt Storage and Road Salting			
Salt Water Intrusion	√	C - D - E	G - D

Contaminant Sources	Highest Priority Sources	Factors Considered in Selecting Contaminant Source*	Contaminants
Spills		D	D - G
Transportation of Materials		D	D
Urban Runoff			
Other Sources Abandon Wells (Unplugged)	√	A - C - D - E	A - B - D - E - G - J - L - M

KEY TO TABLE 18

1	2
A. Human health and/or environmental risk (toxicity)	A. Inorganic Pesticides
B. Size of the population at risk	B. Organic Pesticides
C. Location of the sources relative to drinking water sources	C. Halogenated Solvents
D. Number and/or size of contaminant sources	D. Petroleum Compounds
E. Hydrogeologic sensitivity	E. Nitrate
F. State findings, other findings	F. Fluoride
G. Other	G. Salinity / Brines
	H. Metals
	I. Radionuclides
	J. Bacteria
	K. Protozoa
	L. Viruses
	M. Any Unlisted Surface Contaminate

Overview of State Groundwater Protection Programs

Table 19 contains a summary of the state groundwater protection programs.

The DEQ received authority under HB 2227 and 1002 and S. B. 361 (clean up bill for HB 1002) to be the lead agency for Oklahoma's Wellhead Protection Program. Due to the variety of potential causes and sources of groundwater contamination, other state environmental agencies are involved in this program. These include the ODAFF, OWRB, OCC, Corporation Commission, Wildlife Department, and the Department of Mines.

TABLE 19. SUMMARY OF THE STATE GROUNDWATER PROTECTION PROGRAMS

Program or Activities	Check if Active	Implementation Status	Responsible Agency
Active SARA Title III Program	√	FE	DEQ
Ambient groundwater monitoring system	√	CE	DEQ
Aquifer vulnerability assessment	√	FE	DEQ*
Aquifer mapping	√	CE	OWRB*
Aquifer characterization	√	CE	OWRB*
Comprehensive data management system	√	CE	DEQ
EPA - endorsed Core Comprehensive State Groundwater Protection Program (CSGWPP)	√	CE	DEQ*

Program or Activities	Check if active*	Implementation Status*	Responsible Agency*
Groundwater discharge permits	√	FE	DEQ*
Groundwater Best Management Practices	√	CE - UR	DEQ*
Groundwater legislation	√	CE	OWRB*
Groundwater classification	√	CE	OWRB*
Groundwater quality standards	√	CE	OWRB*
Interagency coordination for groundwater protection initiatives	√	CE	OSE*
Nonpoint source controls	√	UD	OCC*
Pesticides State Management Plan	√	FE	ODAFF
Pollution Prevention Program	√	FE	DEQ
Resource Conservation and Recovery Act (RCRA) Primacy	√	FE	DEQ
Source Water Assessment and Protection Program (SWAP)	√	FE	DEQ
State Superfund	√	CE	DEQ
State RCRA Program incorporating more stringent requirements than RCRA Primacy	√	CE	DEQ
State septic system regulations	√	FE	DEQ
Underground storage tank installation requirements	√	FE	Corp. Comm
Underground Storage Tank Remediation Fund	√	FE	Corp. Comm
Underground Storage Tank Permit Program	√	FE	Corp. Comm
Underground Injection Control Program	√	FE	DEQ*
Vulnerability assessment for drinking water / wellhead protection	√	CE	DEQ
Well abandonment regulations	√	FE	OWRB*
Wellhead Protection Program (EPA - approved)	√	CE - FE	DEQ
Well installation regulations	√	FE	OWRB*

KEY TO TABLE 19

1

CE – Continuing Efforts
FE – Fully Established
NA – Not Applicable
P – Pending
UD – Under Development
UR – Under Revision

2

DEQ–Oklahoma Department of Environmental Quality
OCC – OKlahoma Conservation Commission
Corp. Comm.–Oklahoma Cooperation Commission
OWRB–Oklahoma Water Resources Board
ODAFF–Oklahoma Department of Agriculture Food and Forestry
OSE–Office of the Secretary of Environment
* Indicates multiple agency input into the program

Oklahoma's Wellhead Protection Program

The DEQ developed its Wellhead Protection Program in accordance with the EPA guidelines set forth under the Safe Drinking Water Act ' 1428 (as amended in 1986). Oklahoma's Wellhead Protection Program is a mechanism to assist local communities in protecting their groundwater based drinking supplies. The goal of the Wellhead Protection Program is to delineate protected areas around a drinking water wellhead. In these protected areas, potential causes and sources of groundwater contamination can be identified and managed thus reducing or eliminating the risk of well contamination.

Under Oklahoma's Wellhead Protection Program, managers of groundwater based drinking water systems may contact the DEQ to request technical assistance. The state will also offer technical assistance for such tasks as evaluating the potential for groundwater contamination, determining possible sources of contamination, proposing model ordinances for control of potential sources of contamination, and/or preparing a contingency plan in the event of well contamination. The program advocates land use restrictions around the wellhead. At present, emphasis is placed on educational programs and voluntary implementation of best management practices to reduce or eliminate the need for restrictive regulatory protection.

Groundwater Indicators

The DEQ routinely monitors public drinking water wells for nitrates, coliform bacteria, volatile organic compounds and other drinking water quality parameters. The DEQ has regulatory authority for public water supplies under 63 O.S. 1981, ' 1-901 *et seq*. The regulations were last amended by the Oklahoma State Board of Health on February 8, 1990 (effective May 25, 1990) and incorporated into the DEQ on January 1, 1993 (effective July 1, 1993 and amended July 1, 2003). Under this regulation, a *community water system* is defined as "any public water supply system, which serves residents on at least fifteen service connections or regularly serves twenty-five year round residents." A *non-transient non-community water system* is "any public water supply system that is not a community water system and that regularly serves at least twenty-five of the same persons over six months per year. This definition includes but may not be limited to schools, day care centers, industries and other places of employment." A *non- community water system* is "any public water supply system which serves an average of at least 25 individuals at least 60 days per year but is neither a community water system nor a non-transient non-community water system." Table 20 lists the various supply systems with standards violations. With the exception of nitrate as nitrogen, most of the contaminants are of natural origin. Note that in the "Date Violation Confirmed" column, some violations are of recent discovery and others have been known for several years.

TABLE 20. PUBLIC WATER SUPPLY STANDARDS VIOLATIONS: NITRATE (NO2 NO3), MAXIMUM ALLOWABLE LIMIT 10 MG/L (PPM).

System Name	PWSID#	County	Date Violation Confirmed	Current Level – Date	Compliance Due By Date
North Blaine Water	2000606	Blaine	Feb. 2004	-----	Dec. 2002
North Blaine Water	2000606	Blaine	Feb. 2004	-----	Dec. 2004
Fairview Lakeside Country Cl	2000625	Blaine	Jun. 2003	-----	Jan. 2005
Canadian Co. RWD #1	2000908	Canadian	May 2003	13.8 – Nov. 2003	Jan. 2005
Garfield Co. RWD #5	2002444	Garfield	Jul. 2003	12.2 – Feb. 2004	Jan. 2005
Hollis	2002901	Harmon	Aug. 2000	13.5 – Jan. 2004	Jan. 2004
Okarche	2003703	Kingfisher	Apr. 2003	12.1 – Jan. 2004	May 2004
Okarche RWD	2003715	Kingfisher	May 2003	17.7 – Nov. 2003	Dec. 2002
Kickapoo Env Dept	2004174	Lincoln	Jan. 2002	12.89 – Jun. 2002	Oct. 2004
Logan Co. RWD #2	2004206	Logan	Sep. 2003	12.4 – Feb. 2004	Jan. 2006

Cleo Springs	2004402	Major	Nob. 2003	12.3 – Feb. 2004	Jan. 2006
Major Co. RWD #1	2004407	Major	Dec. 2003	11.9 – Feb. 2004	Jan. 2004
Grandfield	2007502	Tillman	Feb. 2004	-----	-----
Cordell	2007502	Washita	Oct. 2001	18.1 – Oct. 2003	Aug. 2004
Waynoka	2007604	Woods	Aug. 2000	14.3 – Feb. 2004	Jul. 2004

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